Noise and hearing in a trackless-mining environment

by C.L. WORKMAN-DAVIES

SYNOPSIS

Noise is a form of pollution arising mainly from the activities of man. One such activity is mining, in which man, as in many of his other activities, uses machinery of various kinds to achieve safe, healthy, and economic production. Trackless mining makes use of an advanced state of technology over that required in traditional mining methods. One of the advantages of the former, as distinct from any disadvantages it may have, is a reduction in noise levels, the number of people exposed to noise, and the duration of their exposure to noise.

This paper briefly examines why noise is a problem and what various countries are doing about it in terms of standards, codes of practice, and regulations. It also investigates the extent to which noise is a problem in mining and how trackless mining alleviates this problem.

The question is then posed as to whether South Africa is not setting too high a standard at this stage of its national development by comparison with what is being done by other, more-advanced countries.

SAMEVATTING

Geraas is 'n vorm van besoedeling wat hoofsaaklik uit die mens se bedrywighede voortspruit. Een sodanige bedrywighheid is mynbou waarin die mens, soos in baie ander van sy bedrywighede, verskillende soorte masjinerie gebruik om veilig, gesonde en ekonomiese produksie te bewerkstellig.

Spoorlose mynbou maak gebruik van gevorderde tegnologie en verlig die geraasverdeling met dit wat vir traditionele mynboumethodes nodig is. Een van die voordele van eersgenoemde metode, afgesien van enige nadele wat dit mag inhou, is 'n verligging van die geraasstelsel en 'n verminder van die aantal mense wat aan geraas blootgestel word, en van die duur van hul blootstelling aan geraas.

Hierdie referaat gaan kortliks na waarom geraas 'n probleem is en wat verskillende lande in termie van standaarde, gebruikskodes en regulasies daaromtrent doen. Dit ondersoek ook die mate waarin geraas 'n probleem in mynbou is, en hoe spoorsellos mynbou hierdie probleem verlig.

Die vraag word dan gestel van Suid-Afrika nie in hierdie stadium van sy nasionale ontwikkeling 'n te hoë standaard stel verlig met wat deur ander meer gevorderde lande gedoen word nie.

Introduction

For a variety of technical and economic reasons, trackless mining is being practised to an increasing extent in South Africa. One of the consequences of this relatively new method of mining concerns noise and hearing.

The forms of equipment used, be they rock drills or load–haul–dump (LHD) units, are less noisy than their traditional counterparts. They are also more productive and can therefore complete a given amount of work in a shorter time with fewer people. So, by comparison with traditional methods and equipment, trackless mining improves the situation with regard to noise and hearing. In some situations, trackless mining cannot be practised for technical reasons but, in the main, economics is the deciding factor on when and where trackless mining will be used. The question whether trackless mining is implemented or not depends on whether the price that society is willing to pay for the product will cover the costs of production, tax, and profit. This is also related to the grade of ore being mined and the scale of operation.

Trackless mining was first introduced to South Africa in the 1960s in hardrock base-metal mining, mainly at Prieska. The coal mines are also using trackless mining, but the mining of coal, which is soft, presents less of a noise problem. South African hard-rock gold mines have been experimenting with trackless mining since the early 1970s. In gold mines operating on wide orebodies, this form of mining has reached a point where it is now responsible for some 70 per cent of the underground production at Western Areas Gold Mine and some 60 per cent at Randfontein Estates.

In gold mines operating in narrow reefs, trackless equipment is being put to use in developing the tunnels required. Some of these mines are experimenting with trackless mining for the stoping operation, and one can therefore foresee an increasing use of trackless mining, even under these more difficult constraints. This in the context of noise and hearing is an advantage. However, disadvantages are claimed for diesel-powered and electric-powered trackless equipment because of the heat generated and the gas and particulate matter emitted.

Understanding Noise

Noise can be defined as sound that causes problems. The problems consist, firstly, in various forms of annoyance that noise gives rise to and, secondly, the impairment of hearing that may result from long exposure to high noise levels.

Hearing Impairment

Hearing impairment is of two kinds. The first kind affects the ears' capability to hear low-frequency sounds of from about 500 to 3000 Hz, and this limits the ability to listen to the spoken word. This impairment is a hindrance to occupational and social activity. The second
kind of hearing impairment reduces the ears' capability of hearing higher-frequency sounds, from about 4000 to 8000 Hz and more. One's ability to hear these frequencies adds to the pleasure of listening to music and the sounds of nature, and might be regarded as a secondary ability.

Hearing impairment is monitored by audiometric testing. Some of the results are used in the calculation of the binaural hearing impairment (BHI) of a person. This is a measure of the inability of a person to hear speech and is expressed as a percentage. A hearing impairment of up to 25 per cent BHI is regarded as normal, and allows for the effects of aging (presbycusis) and exposure to noise below a recognized standard level and duration. A person with 30 per cent BHI would, on this basis, have a 5 per cent permanent disablement for which he could receive compensation, depending on whether he lives in a country that makes payments for such a disability or not.

**Noise Standards**

The problems of noise have gradually become worse throughout the world, both in the general environment and in the working place. Some countries have recognized it as a form of pollution requiring some sort of remedial action. These countries have studied and researched the situation, and have published various national standards. The standards that are relevant to this paper are those pertaining to occupational noise. Such standards are but a first step in an ongoing process to progressively reduce noise levels in the working place, to reduce the length of exposure to noise, to monitor the hearing ability of people exposed to occupational noise, and to encourage hearing conservation in cases where noise levels and durations have little scope for improvement.

The next step has been for countries to issue codes of practice based on the national standards. These codes do not have the force of law, but are often negotiated between the State and industry to achieve a result that is acceptable from the points of view of both the cost of noise-control measures and the cost of hearing impairment.

The final step is for countries to enact regulations that are legally binding on industry. This final step requires careful consideration in terms of what can be achieved with the resources available and the respective costs that are likely to be incurred.

As can be seen from Table I, South Africa is one of the few countries to have enacted regulations pertaining to occupational noise in industry. In terms of the noise in mines, it is among the many countries that have not yet enacted regulations. However, it is known that the Government Mining Engineer and the Minister of Mineral and Energy Affairs are proposing to have regulations passed in the near future concerning noise in mines.

**Equivalent Noise Level**

At this point, it is important to understand the definition of the various noise levels specified by different countries and the considerations upon which they are based. The level specified is generally based on an equivalent noise exposure for an 8-hour working day in a 40-hour working week for a 40-year working period. This means that a certain accepted percentage of people would be suffering a binaural hearing impairment in excess of 25 per cent, but the rest of the population would not have this problem. For example, the International Standards Organisation in its report ISO 1999 (1982) estimates that, at an exposure of 90 dB(A)Leq, 11 per cent of the persons exposed would have a hearing handicap; at an exposure of 85 dB(A)Leq, 3 per cent of persons would have a hearing impairment; and, at 80 dB(A)Leq, nobody would be affected.

The rationale behind the use of $Leq$ is based on the assumption that damage to hearing is proportional to the total cumulative sound energy received by the ear. Sound waves are a form of energy and, although minute compared with other forms of energy, it is this energy that does the damage. Hence, to assess and control exposure to this risk of damage, one needs a measure that takes both sound level and duration into account. This measure is the equivalent continuous level of sound pressure that would cause the same amount of energy to be received—that is, it would have the same damaging effect on hearing as the varying noise to which the ear is actually exposed. This measure is denoted by $Leq$. If the noise level in a working area is reasonably steady and constant, it can be measured on a simple sound-level meter. If it varies in a random manner (the more usual situation), an integrating sound-level meter is used, or the total dose can be recorded during a working shift on a personal noise-dose meter.

It is important to appreciate that the energy received by the ear, being a combination of sound-pressure level and duration, can be either a high sound-pressure level for a short period or a lower level for a longer period—the damage is the same. Thus, a man working an 8-hour shift at an $Leq$ of 85 dB will receive the same amount of energy, and suffer the same amount of damage to his hearing, as he would in 2 hours if the noise were 91 dB, and in only 15 minutes if the noise were 100 dB.

As shown in Fig. 1 and Table II, the 8-hour base varies between 85 and 90 dB. The choice of base is a question

**TABLE I**

<table>
<thead>
<tr>
<th>Country and regulation</th>
<th>Noise level for an 8 h day dB(A)</th>
<th>Half the exposure time for each increase of dB</th>
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<tbody>
<tr>
<td>USA:</td>
<td></td>
<td></td>
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<tr>
<td>Regulation for industry and mines</td>
<td>90</td>
<td>5</td>
</tr>
<tr>
<td>Canada:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Regulation, but not all provinces</td>
<td>85</td>
<td>5</td>
</tr>
<tr>
<td>Great Britain:</td>
<td>Code of practice recommended for industry and mines</td>
<td>90</td>
</tr>
<tr>
<td>European Community:</td>
<td>Code of practice recommended for industry and mines</td>
<td>90</td>
</tr>
<tr>
<td>Australia:</td>
<td>Standard recommended</td>
<td></td>
</tr>
<tr>
<td>South Africa:</td>
<td>Regulation for industry and proposed regulation for mines</td>
<td>85</td>
</tr>
</tbody>
</table>

Great Britain: Standard recommended 90 3

South Africa: Regulation for industry and proposed regulation for mines 85 3

Working week for a 40-year working period. This means that a certain accepted percentage of people would be suffering a binaural hearing impairment in excess of 25 per cent, but the rest of the population would not have this problem. For example, the International Standards Organisation in its report ISO 1999 (1982) estimates that, at an exposure of 90 dB(A)Leq, 11 per cent of the persons exposed would have a hearing handicap; at an exposure of 85 dB(A)Leq, 3 per cent of persons would have a hearing impairment; and, at 80 dB(A)Leq, nobody would be affected.
of the percentage risk of hearing impairment that is found acceptable. The halving of the daily exposure duration by steps of either 3 or 5 dB is also a matter of choice. This choice is based on whether one accepts, on strictly theoretical grounds, that an increase of 3 dB represents a doubling of the sound energy and therefore requires a halving of the exposure duration. The other, more lenient view is that, after an 8-hour working day, a person has 16 hours within which his ears can rest and recuperate, and it is therefore reasonable to allow a 5 dB increase for each halving of the exposure duration.

Noise from Rockdrills

The manufacturers of rock-drilling equipment have been testing the noise characteristics of their equipment for a considerable time, especially since noise has become a matter for concern. The tests are conducted according to a recognized code, one of which is the CAGI-NEUROP test code (Compressed Air and Gas Institute (USA) and the European Committee of Manufacturers of Compressed Air Equipment).

These tests are conducted on the surface in an environment as close to a free field situation as possible. It is required that the rock drill should be drilling a hole in a block of rock with the drill steel already a certain distance within the rock at the time the noise readings are taken. A maximum of five measurement positions are stipulated at a distance of 1 m from the centre of the rock drill. Although the requirements of the test code do not model reality and, indeed, are not meant to, the code provides at least for a standardized and reproducible set of conditions that can be applied internationally.

Manufacturers can thus monitor changes in the noise characteristics of their equipment as they endeavour to reduce noise levels, and purchasers of equipment can compare the noise characteristics of one manufacturer’s equipment against that of others as one of their decision criteria to be used before purchasing equipment.

However, the concern in this paper is with the noise level likely to be experienced by the operator of the equipment. In such cases, the noise levels to which the drill operator will be exposed are modified by the acoustic properties of the working environment. The absorption coefficient of the surroundings can vary from $\alpha = 0$, where all the incident sound energy is reflected, to $\alpha = 1$, where all the incident sound energy is absorbed. Savich and Wylie illustrate this as shown in Fig. 2.

In the case of pneumatic-powered rock drills, the pressure of the compressed-air supply also has an effect. Fischer determined this as shown in Fig. 3. Another major influence on the noise level is the spatial volume in which a rock drill is drilling. This is readily seen from a consideration of various cross-sectional areas of development ends, as shown by Higginson and reproduced in Fig. 4. This influence would also apply to stopes varying in width from, say, 1 to 4 m.

The power of the machine also plays a part. Some indication of this is given by Savich and Wylie. For an air consumption of 1.5 to 8 m$^3$/min, the noise ranged from 108 to 118 dB(A) and, for an air consumption of 12 to 18 m$^3$/min, the noise ranged from 116 to 123 dB(A).

Another influence is the length of drill steel exposed from the hole. Atmospheric temperature and pressure will also have a small part to play. In addition, there is the matter of several machines working simultaneously. Ordinarily speaking, two pure-tone sound sources of equal sound pressure, when com-

![Fig. 1—Sound level and duration (A South African standard, B US standard)](image)

**TABLE II**

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<tr>
<td>85 dBA base with 3 dBA steps</td>
<td>85 dBA base with 5 dBA steps</td>
<td>90 dBA base with 3 dBA steps</td>
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<tr>
<td><strong>Sound level</strong></td>
<td><strong>Duration</strong></td>
<td><strong>Sound level</strong></td>
</tr>
<tr>
<td>85</td>
<td>8 h</td>
<td>85</td>
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<tr>
<td>88</td>
<td>4 h</td>
<td>90</td>
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<td>91</td>
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<td>112</td>
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<td>118</td>
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<td>121</td>
<td>7 s</td>
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TABLE II

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<td><strong>(D)</strong></td>
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<tr>
<td>90 dBA base with 5 dBA steps</td>
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<tr>
<td><strong>Sound level</strong></td>
<td><strong>Duration</strong></td>
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<td>114</td>
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<td>117</td>
<td>56 s</td>
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<td>120</td>
<td>28 s</td>
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In addition, there is the matter of several machines working simultaneously. Ordinarily speaking, two pure-tone sound sources of equal sound pressure, when com-
Noise from LHD Equipment

In a similar way as for rockdrills, some manufacturers of LHD equipment have been testing the noise characteristics of their equipment.

Table IV shows a range of noise levels based on a summary of information, which, again, was obtained from a variety of sources. The table, which includes both surface and underground measurements, shows that the measurements are influenced by the acoustic properties of the environment in the same way as they were for rockdrills.

In a few instances, some of the equipment was designed and fitted with soundproof cabs. In general, however,
Coping with Rockdrill Noise

It can be seen from the results presented in Table III that, irrespective of the standard being considered, a pneumatic low-powered hand-held rockdrill operator is exposed to high noise levels, of the order of 115 dB. He should therefore be exposed only for a duration ranging from, at worst, 28 seconds per day per 40 hour working week for 40 years (the standard used by South Africa) to 15 minutes per day per 40 hour working week for 40 years (the standard used by the MSHA in the USA). Similarly, the operator of a hydraulic high-powered jumbo-mounted rockdrill is exposed to noise levels of the order of 100 dBA, and could work for a duration ranging from, at worst, 15 minutes per day per 40 hour working week for 40 years to 2 hours per day per 40 hour working week for 40 years. Thus, on a daily basis, the operator is being over-exposed to noise.

The problems involve the following:

(a) the extent to which pneumatic and hydraulic rockdrill systems can reasonably be silenced,
(b) the extent to which operators can reasonably be housed in sound-proof cabs,
(c) the extent to which an operator can be exposed to such noise for a shorter period than 40 years, say 5 years, and not suffer hearing impairment,
(d) the extent to which use should be made of already-deaf people as operators, and
(e) the extent to which operators can reasonably wear hearing-protective devices.

Engineering research and development have been undertaken in many parts of the world to address problems (a) and (b) and some improvement is possible. In some countries that have been able to afford it, changes have been implemented. However, there is still a technical problem and no one country has been able to implement reasonable changes to a sufficient extent. Problem (c) is being partially solved in practice because some people are promoted or transferred out of a noisy occupation, or they resign from such work. The problem remains for those that are to continue permanently in a noisy occupation. The idea behind point (d) seems bizarre at first, but not more so than the practice of some US companies who are deliberately employing mentally retarded people for certain work.

Personal Protection

Ear protection can be specified where it is not practical or economic to reduce noise levels to meet the acoustic objective without individual ear protection. However, with the wearing of any protective equipment (such as car safety belts), there is a human reluctance to make full use of what is available.

There are three basic forms of personal protection.

(1) Temporary ear plugs, which are formed from disposable material and have the advantage of being hygienic, easily dispensed, and able to be worn with helmets and spectacles. However, they constitute a recurring cost.

(2) Ear plugs, which are made in different sizes for they must fit tightly to be effective. They are relatively inexpensive and durable, and are not encumbered by helmets and spectacles. They can be uncomfortable when worn for long periods and are difficult to keep clean in a mining environment.
Ear muffs, which are rigid cups designed to completely cover the ears. Each cup has a soft cushion filled with plastic foam or fluid to ensure a good seal between cup and head. The cups are held in place by an adjustable headband when no hard hat is worn, or can be attached as part of the hard hat. In either case, they are relatively heavy and expensive, and may be difficult to wear for long periods in hot, humid, or dusty conditions.

The most important consideration in the design of a hearing protector is its sound attenuation, which depends both on the frequency characteristics of the noise in which it is worn and the quality of the fit. Generally, protectors attenuate noise at high frequencies better than at low frequencies.

Thus, it can be seen that a range of suitable devices capable of attenuating noise are available for personal hearing protection. Laboratory tests might show an ability to attenuate 20 to 30 dB, but in practice it is more reasonable to expect an attenuation of 15 to 20 dB because of the possibility that the device may not fit properly (Fig. 5). There is also the problem of educating and motivating workers to wear these devices consistently since they are a nuisance and encumbrance in themselves.

However, if such objections and difficulties could be overcome, the result would be that pneumatic low-powered hand-held rockdrills could be used for 15 minutes to 2 hours a day for a 40-hour working week for 40 years. The hydraulic high-powered jumbo-mounted rockdrill (trackless) could be used for 8 hours and longer per day.

The Noise Benefit of Trackless Mining

From the points of view of the reduction of noise levels, the duration of exposure, and the number of people exposed, trackless mining is an attractive method. The noise levels of trackless-mining equipment are lower than the traditional equipment used. Because of its production capacity, trackless equipment is also able to produce more in a shorter time with fewer people. For example, a wide orebody being mined with trackless equipment might require only 80 people for the same production. This means that only 80 people would be exposed to a lower noise level for a shorter duration, and these changes all contribute to an overall improvement in the long-term level of hearing ability of the 80 people employed.

These considerations give an idea of the benefit to noise reduction that can be expected from the use of trackless equipment. There are obviously other, more important advantages and disadvantages to be considered, and these, together with the mining circumstances and costs involved, will determine the practices that are implemented.

Noise Standards for South Africa

What South Africa can afford in terms of a noise standard can be summed up with the help of Fig. 6, which is based on an approach towards environmental quality discussed by Fugel and Rabie. Lower noise levels, lower dust levels, lower water-pollution levels, lower levels of toxic chemicals, lower gas levels, and lower accident statistics can all be regarded as components of environmental purity.

In a comparison of the optimum level of environmental quality for Society 1 and Society 2 (Fig. 6), it can be seen that Society 2 has a higher level of environmental quality ($Q_2 > Q_1$) at a lower cost ($P_2 < P_1$). The optimum level of environmental quality depends on the value a society puts on environmental purity and on the state of technology existing in that society. For Society 1, the costs ($MC_1$) of achieving a given level of environmental quality are relatively high owing to poor technology, and the benefits ($MB_1$) from a given level of environmental quality are relatively low owing to greater concern for more pressing needs. Society 2 is able to achieve higher levels of environmental quality at lower cost ($MC_2$) because of improved technology, and to realize greater benefits ($MB_2$) owing to the higher valuation that it places on environmental purity.

Society 1 could, for example, be thought of as South Africa and Society 2 as the USA. In the case of noise, South Africa has set a higher standard of environmental quality than has the USA. However, South Africa has a lower overall state of technology than the USA, and
the benefits that South Africa can derive from a given level of environmental quality are relatively low owing to a greater concern for more pressing needs. If one accepts the general principle embodied in the graph of Fig. 6, one must conclude that South Africa is perhaps over-concentrating on its noise standard at the expense of achieving other more pressing needs. Support for this statement is gained through a consideration of the experience of the USA and Great Britain.

‘In the USA the original proposed OSHA workplace noise standards of 85 dB would have cost industry between $18 billion and $31 billion (in 1976 dollars) to meet. The compromise standards that OSHA finally worked out will allow 90 dB, but will still cost industry about $250 million’11.

‘In Great Britain when legislation of this kind is about to be enacted there is always an outcry from industry that the measures proposed will adversely affect their business. In this case, what arguments could be made against the proposed regulations? First, perhaps, is the fact that additional investment will be needed at the workplace to meet the regulations, which will naturally increase costs and could lead to a lack of competitiveness with overseas industry... Mr Harris, a member of the Council of the British Society of Audiology has said that the decision to adopt 90 dB(A) as an action level undoubtedly reflects on Britain’s present economic position and added that the proposed legislation is a very welcome step forward’12.

Conclusions
A reduction in noise levels and duration of exposure, and hence a reduction in noise-induced hearing impairment, is an admirable objective. The implementation of trackless mining is fortuitously a move in this direction. Trackless mining, being a newer state of technology has a production capability that requires far fewer people than do traditional methods of mining, and this mini-

zises the number of people exposed to occupational noise in mining. It is pertinent to ask what alternative employment is available for those now without a mining occupation. A correct balance must be struck between safety and health, occupational security, and the price that society must pay for its raw materials. It is only society at large that can take this decision, but people in the mining industry must ensure that they participate in the debate.

References
3. CAGI-PNEUROP. Test code for the measurement of sound from pneumatic equipment. 1st edition. 1969. 20 pp. Compressed Air and Gas Institute (CAGI of USA) and European Committee of Manufacturers of Compressed Air Equipment (PNEUROP).

Book review


Reviewer: W.H. van Niekerk

This volume contains the proceedings of a conference held in London in September 1984. The aim of the conference was to address interdisciplinary but related problems in kinetics and mass transfer. The subject matter is divided into five categories: Characterization, Kinetics, Modelling Studies, Mass Transport, and Industrial Topics, as well as an introductory paper that provides an overview of mass transport in oxides.

The characterization section discusses recent advances in characterization studies, such as high-resolution powder neutron diffraction.

The kinetics section, containing the bulk of the papers, covers various topics ranging from aluminium and silicon ordering in minerals to the reaction mechanism between magnesium oxide and chromite at 1530°C.

Four papers are included under modelling studies, again covering rather diverse topics, including model intercalation studies and computer simulation studies of silicates.

New techniques for the study of mass transport in oxides are the subject of the introductory paper in the mass transport section, which also includes papers on various diffusion studies, for example cation diffusion in natural silicate melts.

The last section, containing four papers, is introduced by a paper indicating how studies of mass transport can be applied to industrial problems.

On the whole, the organizers succeeded in attracting interesting papers for the various subjects, all of them related to silicate and oxide systems in one way or another. The book clearly shows that many fundamental problems are interrelated in the different disciplines. Consequently, it makes stimulating reading, and may provide the reader with a new approach to a difficult problem.

The book will be of value to nearly all who are interested in kinetics and mass transfer, but especially to material scientists, chemists, ceramicists, and engineers working in research environments.
SPOTLIGHT
on ‘Ferrous Pyrometallurgy: A Challenge for South Africa’
by D. WILSON*

Introduction
The Technical Programme Committee—Metals Technology of The South African Institute of Mining and Metallurgy, in association with its Vaal Triangle Branch, held a one-day colloquium on 18th April, 1989, the theme being ‘Ferrous Pyrometallurgy: A Challenge for South Africa’. The venue was the Auditorium 100 at the campus of the Vaal Triangle Technikon in Vanderbijlpark.

A total of 93 delegates attended the Colloquium, which was given a touch of international flavour by the presence of a delegate from France and one from Zimbabwe. These were respectively Mr P. Faure, an engineer representing Pechiney Electromet (France), and the General Manager of the Kwe Kwe Division of Union Carbide, Zimbabwe.

Opening Address
The proceedings were opened by Professor R.J. Dippenaar, Chairman of the Technical Programme Committee—Metals Technology, who introduced Mr C.E. Fivaz, President of the Institute. Mr Fivaz, in his opening address, made special mention of the two international delegates, adding that it was particularly important that a delegate had travelled from France to attend the Colloquium. He said that the Institute was pleased to be able to present the Colloquium in the Vaal Triangle. He added that, as the aim of the Vaal Triangle Branch was to promote an interest in physical and pyrometallurgy, the Colloquium had been scheduled for the area to assist in meeting this objective. He regarded the role of the Branches as fundamental in strengthening the Institute, and in serving to broaden the Institute’s base in the mining and metallurgical industry. The Institute had an important role to play in the economy by promoting the application of science and technology in industry, and the papers to be read at the Colloquium would most certainly help to fulfil this role.

Technical Papers
In the first session, chaired by Mr J.L. Nel of Iscor, four papers were presented. Dr R. Falcon of Falcon Research Laboratories presented a paper entitled ‘The relationship between the properties of coal and the efficiency of reduction in coal-based reduction processes’. She discussed the relevance of some of the fundamental properties of coal in relation to its efficiency as a reducing agent in non-blast-furnace technology. The paper proposed that South African coals should be characterized in more detail in order to match them more adequately to the newly developing direct-reduction technologies of the future. In his paper, ‘Solid state reduction of composite chromite pellets in an externally heated moving-bed shaft furnace’, Mr M.J. Niayesh of Mintek described the development of a computer model for simulating the prereduction of composite chromite pellets and the methods used to verify the predictions. The paper ‘Description of non-ideal slag and metal systems by the intermediate compound method’, presented by Mr R.T. Jones of Mintek, examined a model that attributes deviations from ideal solution behaviour to the formation of complex component liquids and solid phases. Mr A. de Sousa of Afrox presented a paper describing an exploratory study of the primary business objectives of South African mining and metallurgical organizations. His paper was entitled ‘In search of excellence in the South African mining and metallurgical industries’.

Three papers were presented in the second session, which was chaired by Dr F.W. Guldenpennig of Usko Limited. ‘The production of high-quality clean steel in a continuous billet-casting operation’, presented by Dr M. van Wijngaarden of Usko Limited, identified and discussed the critical areas in the operation and their effect on the production of high-quality clean steel at a competitive price. Mr G. Andrew of Fedgas, in his paper ‘Refining of silicon metal and ferrosilicon alloys’, described the Fesirox process, which has as its principal feature a bottom-blown shrouded nozzle with which oxygen as the active component and an inert gas as the mixing agent are fed into the melt. ‘The use of oxygen in pyrometallurgy’ was the title of the paper presented by Mr E. Frommolt of Fedgas, who showed how the range of oxygen applications has grown continuously in recent years as a result of the need to make energy-intensive combustion processes more economical.

During the afternoon session, which was chaired by Mr J.P. Hoffman of Middelburg Steel & Alloys, four papers were presented. Mr D.W. de Vos of Iscor presented a paper on ‘The commissioning of the desulphurization plant at Iscor’s Pretoria Works’, which discussed the commissioning and operation of the Injetall Side Injection Device (ISID), and the determination of the optimum process variables. ‘The charging of high percentages of liquid iron to an electric arc furnace: Experience gained, present status, and future prospects’, by Mr M. Fischer of Iscor discussed the establishment of a safe and economical practice that makes possible the use of hot metal of varying quality. Mr D. Hayman of Mintek, in his paper ‘Mintek’s new 1 MW plasma furnace’, described the major reconfiguration of the facility. ‘A new immersion probe system for the quick determination of hydrogen in molten steel’ was presented by Mr P. Faulkner of Electro-Nite and described the system developed for an accurate on-line measurement of the hydrogen content.

The delegates responded well to the technical presentations, and the discussion sessions were well utilized to
expand on the contents of the various papers.

General
The morning of 18th April was certainly one that had all the early-rising delegates muttering that winter had arrived early this year. The delegates were eager to speed up the registration process so that they could be comforted by the tea, coffee, and toasted sandwiches that were to follow and, as always, the competent secretariat handled the registration efficiently.

The venue seemed to be popular with most of the delegates and, as usual, the catering was of a high standard. A good turn-out of delegates enjoyed the post-Colloquium cocktail party, and it was even remarked that the Phys Mets may soon thaw enough to provide a serious challenge to the party-loving miners!

All in all, the Colloquium must be recorded as having been very successful, and the Vaal Triangle must be regarded as a possible venue for future events of a similar nature.

Acknowledgements
The Technical Programme Committee thanks all those who contributed to the success of the Colloquium, particularly Pam Binstead for her administrative abilities, the Vaal Triangle Branch for arranging the venue, the Vaal Triangle Technikon for the use of their facilities, and the following companies for financial assistance: Afrox (Pty) Ltd, Cullinan Refractories, Falcon Research Laboratory, and Valley Refractories.

Project and contract management
A Project and Contract Management Conference is to be held on 19th and 20th September, 1989, at the CSIR, Pretoria. A faculty of highly experienced executives will address this working Conference on the various critical aspects of project and contract management, which is, in practice, one of the most complex forms of management to execute. It calls for special skills, as well as a clear understanding of the diversity of technical human relations and financial factors governing the project's progress and success.

Despite this, little training is given to contract managers in South Africa; yet new managers need to be trained and old managers retrained. Project and contract management involves an extraordinary team effort with collective creativity and the highest professional skills. Executed correctly, project and contract management can be very rewarding. Done wrongly, it can be a financial and human disaster.

Today's project and contract managers face a grave shortage of skilled manpower, go-slow actions by Unions, construction technology doubling every five years, material costs escalating at the rate of 1.7% or more a month, cost overruns, and the increasing difficulty of relating cost to schedule during the course of a project.

Delegates attending the Conference will obtain a solid grounding in the principal tools and techniques necessary to effectively manage and control contracts—how to complete projects in the shortest time, at the lowest cost, and with the highest quality.

The Conference will include the difference between project and contract management, how to develop your own project-and-contract-management company, leadership in running a project, value engineering, problem solving and decision-making, handling the international contract, computerized project and contract management, management quality, and the future outlook and applications of contracting management. Those attending must be project managers, contract managers and engineers, estimators, quantity surveyors, consulting and site engineers, quality assurance managers, and clerks-of-work.

For further information on this essential Conference, telephone Joanna Bown at Whitehead Morris (Pty) Ltd on (011) 789-1574.

Powder metallurgy
The PM 90 exhibition is to be held in Wembley, London, from 2nd to 6th July, 1990. The wide range of powders, processing machinery, and powder metallurgy components at the exhibition will reflect the growth in this highly specialist industry.

Metal powders are metallic elements or alloys in finely divided particulate form. These powders offer a series of unique raw materials whose applications are limited only by imagination and the fundamental properties of the metal. In addition to their use in powder metallurgy parts and products, metal powders are used in welding applications, decorative coatings, medical and dental applications, office copiers, electrical applications, pyrotechnics, and nuclear engineering.

The exhibition is being run alongside the International Powder Metallurgy Conference, which is being organized by The Institute of Metals on behalf of The European Powder Metallurgy Federation.

For further information about the PM 90 Exhibition, please contact
Doris Stidston
Mack-Brooks Exhibitions Ltd
Forum Place
Hatfield
Hertfordshire AL10 ORN
England.
Tel: 07072 75641, telex: 266350, fax: 07072 75544.

Details about the PM 90 Conference can be obtained from
Jane Butler
Institute of Metals
1 Carlton House Terrace
London SW1Y 5DB
England.
Tel: 01 839 4071, telex: 8814813.
Castings and forgings

Exhibition organizers, FMJ International Publications Ltd, are set to build upon the success of Castings & Forgings '88, which was held as a joint event with Patt-Cast '88. Castings & Forgings '89—with Patt-Cast '89—has already generated a high level of interest, which has been reflected in the demand for stands.

Castings & Forgings '89—the exhibition for buyers and specifiers of castings and forgings—with Patt-Cast '89—the exhibition for the pattern making industry—will be held at the Telford Exhibition Centre, Shropshire, England, on 3rd and 4th October, 1989. The event is sponsored by the British Forging Industry Association, British Foundry Association, Diecasting Society, Institute of British Foundrymen, Institute of Purchasing and Supply, and the National Society of Master Patternmakers, and is supported by the journals Castings Buyer, Foundry Trade Journal, and Metals Industry News.

Accompanying the exhibition will be a major, one-day, conference 'Developing a Market Strategy', organized by The Institute of British Foundrymen and the British Cast Iron Research Association (BCIRA), which is to be held on 3rd October, 1989.

The subjects to be presented include

- The urgent need for the effective marketing of castings, both by individual foundries and by the foundry industry in general
- The difference between marketing and selling
- Effective casting buying for a multi-national group
- International marketing of castings—challenges and opportunities
- Effective advertising of castings—where, when, and how
- Establishment of an effective strategic marketing plan
- Case studies by practitioners.

Further information can be obtained from
Mr P.J. Wakeman
Technical and Courses Co-ordinator
Institute of British Foundrymen
3rd Floor
Bridge House
121 Smallbrook Queensway
Birmingham B5 4JP
England.
Tel: 021 643 4523.

For further information on the exhibition, contact
Brian Wilkinson
Exhibition Sales Manager
Castings & Forgings/Patt-Cast '89
Queensway House
2 Queensway
Redhill
Surrey RH1 1QS
England.
Tel: 0737 768 611 Fax: 0737 761 685
Telex: 948669 TOPJNL G.

Furnaces

FURNACES '90, the eighth in this series of exhibitions for the thermal-processing industry, will be held in Solihull, West Midlands, England, on 6th and 7th March, 1990. The show is sponsored by the British Industrial Furnace Constructions Association (BIFCA), the Contract Heat Treatment Association, the Wolfson Heat Treatment Centre, and the journals Metalurgia and Metals Industry News.

The exhibition will be of interest to personnel involved in purchasing or specifying plant and related materials. They will have the opportunity to view a full range of plant and equipment, plus the diverse range of services associated with furnace technology and thermal processing.

The categories of equipment that will be on display include the following:

- Heat-treatment furnaces
- Re-heating furnaces
- Melting furnaces
- Kilns and ovens
- Laboratory furnaces and analytical equipment
- Burners and electric elements
- Controls and instrumentation
- Furnace repair and engineering services
- Fume and dust extraction
- Refractories.

Complementing the exhibition, there will be a two-day conference consisting of technical presentations from leading companies and authorities. This is being organized jointly by FMJ International Publications Ltd and BIFCA. Further details will be available shortly.

For further details on the FURNACES '90 Exhibition, please contact
Ray Morris
Exhibition Sales Manager
FURNACES '90 Exhibition
Queensway House
2 Queensway
Redhill
Surrey RH1 1QS
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